ENERGY COST REDUCTION MEASURES IDENTIFIED FOR TEXAS STATE AGENCIES

TIMOTHY J. GRIGG
Program Manager

MALCOLM E. VERDICT
Assistant Director

Energy Efficiency Division
Public Utility Commission of Texas
Austin, Texas

ABSTRACT

According to energy auditors, state-owned facilities in Texas on the average consume over twice the energy of comparable facilities in the private sector. In 1984 and 1986 as part of the Texas Energy Cost Containment Program, two extensive energy audit programs examined a total of 35.3 million square feet of state-owned space. Energy cost reduction measures with paybacks of four years or less were identified. The purpose of this paper is to present the projects identified in 1986. Most relate to lighting, HVAC, and energy management systems. The type of facilities audited include colleges and universities, health science centers, state schools and centers, hospitals, and office buildings. The relation between the facility type and the energy cost reduction measures identified is discussed. In addition, the energy and dollar savings derived from the identified measures at the different facilities are presented. The total savings of the projects identified in both energy audit programs amount to $23.7 million annually.

INTRODUCTION

In 1984 and 1986, the Energy Efficiency Division of the Public Utility Commission of Texas, using oil overcharge funds returned to the state, provided energy audits to 80 state agencies on a request basis. The audits were similar in format to the Federal Institutional Conservation Program, but were streamlined to identify only the best cost reduction opportunities with paybacks of four years or less. Both maintenance and operations and capital retrofit recommendations were included in the reports. Detailed audits were performed at 114 separate facilities. Overall, approximately 35 percent of the State's conditioned space was surveyed.

These audits were offered as part of the ongoing State Energy Cost Containment Program (SECCP). The SECCP was started in 1983 to identify ways of reducing the State's rising utility costs. The State's electrical and natural gas costs increased five-fold from $42 million in 1974 to $207 million in 1984 (see Figure 1). The recent drop in energy costs, primarily due to lower natural gas prices and the use of state-owned gas, lowered the State's 1986 bill to $188 million. Note that these costs are only for electricity and natural gas. Large amounts of thermal energy (chilled water and steam) are also purchased, but records on these costs are not readily available.

ENGINEERING AUDITS

The 1986 audit program resembled the 1984 program in many respects. Both identified low cost and no cost maintenance and operation conservation opportunities and capital intensive energy cost reduction measures. Though more square feet was audited in 1984, more utility cost savings per square foot were identified in 1986. Changes in the screening process, the audit report format and the technical review process were the main reasons for this. In screening, attention focused on eliminating the facilities which were least in need of an audit. The audit report format in 1986 required that more information be collected and analyzed during each audit, resulting in more potential measures being identified. The technical review process incorporated the local facility manager, who reviewed and critiqued the draft report. More engineering firms were fielded in 1986, which reduced the amount of space each firm had to audit, thus slowing the work pace. With the reduced work pace and increased information being collected, more potential measures were identified. Firms with expertise in HVAC and controls were also retained to audit the more complex structures. In addition, more health science centers were audited in 1986 which, as this paper will show, contain some of the greatest utility cost reduction opportunities in the state.

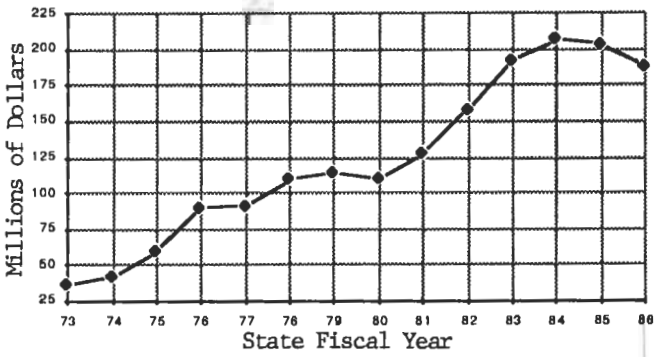

Figure 1. State of Texas Utility Costs

Proceedings of the Fourth Symposium on Improving Building Systems in Hot and Humid Climates, Houston, TX, September 15-16, 1987

The overall payback for 1986 is 2.4 years, which is longer than the 1.7 years for 1984. This is due mainly to two reasons. First, energy costs were lower in 1986 than in 1984, which lengthens the payback period. Second, the requirement that more information be collected and analyzed resulted in more capital intensive recommendations.

The audits identified both maintenance and operation (M&O) measures and energy cost reduction measures (ECRM). In the audit reports, M&O's are those measures which should normally be performed by maintenance staff and have no implementation costs. ECRM's are measures which have implementation costs. Many of the ECRM's can be performed by maintenance staff but have implementation costs and are thus classified as ECRM's.

The audited facilities can be broken down into five basic types: (1) office buildings, (2) state schools and centers, (3) state hospitals, (4) health science centers, and (5) colleges and universities. The pie charts in Figures 2 and 3 illustrate the state-owned space audited in 1984 and 1986, respectively, by agency type. Figure 4 shows the audited space by agency type for both years.

1984 AUDITS

In 1984, three engineering firms and the Texas Engineering Extension Service (TEEX) conducted the audits. Seventy-three state facilities representing 22 percent of the state's building space (based on 1983 figures) requested engineering audits. Of the 73 state facilities audited, 68 audits identified projects with paybacks of four years or less.

Almost 21 million square feet of state buildings were audited, resulting in 550 specific recommendations for reduced energy costs. Annual cost savings totaling $9.2 million were identified. Total implementation costs for all 550 recommendations were estimated to be $15.6 million with a simple payback of 1.7 years.

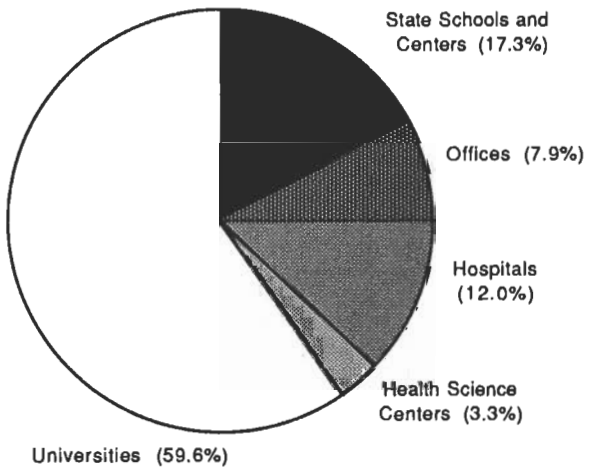

Figure 2. 1984 Agency Types Audited (20,810,136 Sq. Ft. Total)

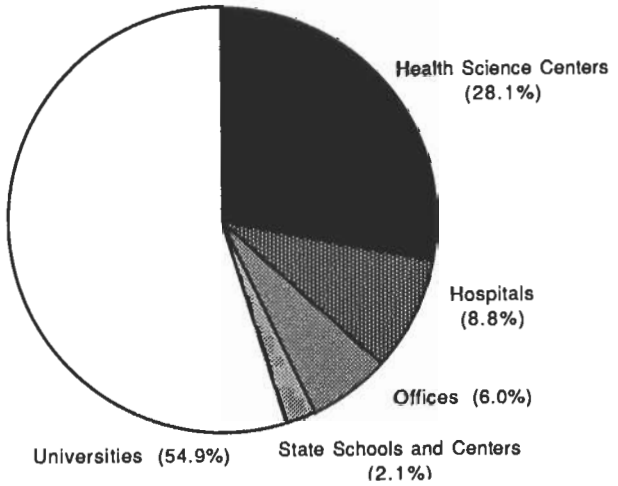

Figure 3. 1986 Agency Types Audited (14,865,476 Sq. Ft. Total)

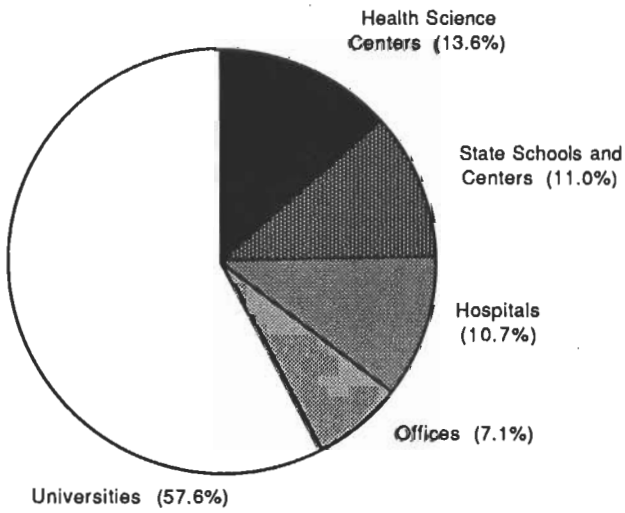

Figure 4. Agency Types Audited Both Years (35,675,612 Sq. Ft. Total)

1986 AUDITS

Five engineering firms and TEEX participated in the 1986 audit program. There were 60 agency requests for audits. Some of the requests included space previously audited in 1984. Many agencies also requested buildings which did not meet the program criteria. Therefore, only 34 agencies received audits. Forty-six separate state facilities were audited.

In all, 601 seperate energy cost reduction recommendations were identified in 14.5 million square feet of state building space. Annual cost savings of over $12.5 million were identified. Total implementation costs were estimated at $29.9 million for a combined payback of 2.4 years.

1986 AUDIT RECOMMENDATIONS

Slight differences in the 1986 and 1984 audit format make these data incompatible for detailed analysis and comparison. For this reason, only 1986 data is presented and analyzed in this paper. A prior analysis of the 1984 data is presented in the report "Cost Containment through Energy Efficiency in State Buildings", April 1985, Public Utility Commission of Texas.

The audit recommendations are grouped into nine categories, as listed in Table 1. All categories, except two, are self descriptive. Electric service measures deal with changes in electric billing rates, metering changes, and power factor correction. Miscellaneous incorporates all measures not suited for the other categories. Table 1 presents the implementation costs and annual savings for each category in order of simple payback. The figures represent only ECRM costs and savings. M&O's are not included. Identified M&O's savings total $481,624. This is only 3.8 percent of the total savings identified.

The category with the fastest payback is boiler recommendations, with a 0.65 year payback. The categories presenting the greatest potential savings are lighting, variable speed drives (VSD), and HVAC, with paybacks ranging from 2 to 2.87 years. With a combined savings of just under $10 million, lighting, VSD, and HVAC measures account for 80 percent of all savings identified. This is expected, since lighting and HVAC are the largest energy consumers in a building.

Energy management systems also show a good payback, with savings of just under $1 million. It is likely that there are additional savings opportunities available from energy management systems. The scope of the audit work precluded detailed analysis for these systems at most facilities.

The categories with the longest paybacks are energy recovery at 4.3 years and building shell at 4.68 years. Very little opportunities exist for energy recovery measures in the type of facilities audited. Building shell retrofits rarely have paybacks of under four years. Combined, these two categories represent only 3 percent of the total potential savings.

BUILDING TYPES

Table 2 lists the implementation costs and annual savings per square foot for the audited facilities by building type. Maintenance and operation savings are included in this table. A sufficient number of academic buildings, medical research facilities, libraries, hospitals, and office buildings were audited to transfer the information presented to other similar facilities across the state. However, only a small number of natatoriums, museums, central plants, laundries, and kitchens were audited. Therefore, the information for these building types should not be used for comparative purposes.

The implementation costs per square foot ranged from $.12 for kitchens to $19.00 for central plants. Savings per square foot ranged from $.08 for kitchens to $7.08 for central plants. It is natural to expect central plant measures to be the most capital intensive since they are the most energy intensive. However, when in use, kitchens and laundry operations are also energy intensive. The low cost and savings figures shown here are misleading since the audited kitchens and laundries are only used part of the time. As a result, sufficient cost savings could not be generated to justify implementing measures which might normally have paid for themselves within four years if operated full time. Also, as stated above, only a small number of these building types were audited.

Among the building types where numerous buildings were audited, implementation costs range from $0.66 per square foot for office buildings to $3.62 per square foot for medical research buildings. Savings range from $0.36 for office buildings to $1.33 for medical research. Computing the simple payback, libraries and office buildings have the fastest payback. They are also the least expensive (per square foot) to implement. Hospitals, academic and medical research buildings have longer paybacks and higher implementation costs per square foot. However, they represent the greatest amount of potential savings because they consume more energy and constitute a majority of the State's utility bill.

The numbers in parentheses in Table 2 present the data without the Medical School Building at the UT Health Science Center at Houston for medical research buildings and without the M. D. Anderson Hospital at the UT System Cancer Center for hospitals. These two buildings were large enough to affect the cost and savings per square foot for their respective building types. M. D. Anderson also received a customized audit since some major energy projects had previously been identified there. Omitting these facilities results in lowered costs and savings for medical research buildings, and increased savings and a shorter payback for hospitals. Medical research buildings still have the longest payback, but hospitals now have the quickest paybacks and the greatest savings per square foot.

TABLE 1. ENERGY COST REDUCTION MEASURE CATEGORIES RANKED BY PAYBACK (DOES NOT INCLUDE M&O'S)

CATEGORY	IMPLEMENTATION COST	ANNUAL SAVINGS	PAYBACK (YES)
BOILER	$ 350,952	$ 481,920	.73
ELECTRIC SERVICE	52,500	50,066	1.05
VARIABLE SPEED DRIVE	7,495,342	3,745,017	2.00
LIGHTING	4,241,572	1,894,561	2.24
ENERGY MANAGEMENT SYSTEMS	2,289,898	945,452	2.42
HVAC	12,111,893	4,002,890	3.03
ENERGY RECOVERY	1,471,814	342,498	4.30
BUILDING SHELL	368,958	75,701	4.87
MISCELLANEOUS	1,570,951	561,409	2.80
TOTAL	$29,953,880	$12,099,514	2.48

TABLE 2. COSTS & SAVINGS PER SQUARE FOOT BY BUILDING BY BUILDING TYPE (INCLUDES M&O SAVINGS)

BUILDING TYPE	AUDITED SQ. FT.	$ COST / SQ. FT.	$ SAVE / SQ. FT.	PAYBACK (YRS)
ACADEMIC	6,155,941	1.83	.78	2.35
MEDICAL RESEARCH	3,079,293 (2,192,106)	3.62 (2.43)	1.33 (.96)	2.72 (2.53)
HOSPITAL	2,097,170 (987,849)	2.14 (2.29)	.97 (1.51)	2.19 (1.52)
LIBRARY	1,519,289	.85	.55	1.55
OFFICE	889,590	.66	.36	1.83
NATATORIUM/GYM	219,251	.93	.48	1.94
MUSEUM	217,171	.30	.13	2.31
CENTRAL PLANT	44,262	19.00	7.08	2.68
LAUNDRY	24,986	1.46	.36	4.06
KITCHEN	12,758	.12	.08	1.50
TOTAL	14,259,711 (12,263,203)	2.10 (1.79)	.88 (.82)	2.39 (2.18)

Numbers in parentheses do not include U.T. Health Science Center at Houston and U.T. System Cancer Center (M.D. Anderson Hospital).

Table 3 lists the recommendation categories with the greatest potential savings for the State for each of the major building types.

RETROFIT FUNDING

Significant utility savings totalling over $21 million are available to the State if the projects identified in the 1984 and 1986 programs are implemented. A fifty percent return-on-investment is available on the combined projects at current energy prices. Potential funding sources available to individual State agencies are:

- Fund the maintenance and operation and the low cost measures out of currently available utility funds. Higher education agencies can use utility funds for projects having paybacks under two years.
- Fund capital improvement projects out of State general revenue funds. This may prove difficult due to the State's current fiscal status.
- In the absence of direct State funding, alternative financing such as revenue bonds, equipment leases, third party financing, or a State revolving loan fund using oil overcharge funds returned to the State should be considered.

CONCLUSIONS

Findings from energy audits conducted in 1986 of over 14 million square feet of State-owned space indicate that $12.5 million can be saved annually with a one-time implementation cost of $29.9 million for a total payback of 2.4 years. Combine this with the findings of the energy audits performed in 1984, the State can potentially save $23.7 million from an investment of $45.5 million. This is a payback of 1.9 years - less than one budget cycle for the State.

The 1986 audit findings indicate that the items with the greatest potential savings are HVAC and variable speed drive recommendations in academic and medical research buildings. Items with the fastest payback are boiler recommendations (for all building types except offices). The least attractive items were building shell and energy recovery recommendations.

Libraries and office buildings have the fastest payback of all building types. They are also the least expensive, per square foot, to implement. Hospitals, academic and medical research buildings have longer paybacks and higher implementation costs per square foot. However, they represent the greatest amount of potential savings because they use more energy and constitute a majority of the State's utility bill.

The audit programs of 1984 and 1986 covered most of the current audit opportunities for the State. Implementation of the identified energy cost reduction measures is now needed. Investment in these opportunities is extremely cost effective. The rate of return on the investment is high, and the savings will continue to accrue throughout the useful life of the building, typically twenty years or more. The savings identified in 1986 were calculated using current, low energy costs. When energy costs rise again in the future, as they are certain to do, the savings will be much greater than predicted in this paper.

ACKNOWLEDGEMENT

The authors gratefully acknowledge Randy Schrecengost, Richard Lum, and Dr. Warren M. Heffington at Texas A&M University and Francois Abou-Jaoude at the Public Utility Commission of Texas for their efforts in collecting and checking the data used in this paper.

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TABLE 3. COST, SAVINGS AND PAYBACK FOR THE CATEGORIES WITH THE GREATEST POTENTIAL COST SAVINGS FOR EACH OF THE MAJOR BUILDING TYPES (DOES NOT INCLUDE M&O'S)

BUILDING TYPE	CATEGORY	# MEASURES IDENTIFIED	IMPLEMENTATION COST	ANNUAL SAVINGS	PAYBACK
Academic	HVAC	22	4,011,192	1,199,605	3.34
	Lighting	75	1,349,095	645,245	2.09
	VSD	39	5,212,300	2,337,519	2.23
	Boiler	5	47,658	44,102	1.08
Medical Research	HVAC	17	6,603,426	2,330,758	2.83
	Lighting	43	1,508,331	536,194	2.81
	VSD	14	645,140	434,980	1.48
	Boiler	3	6,000	105,201	.06
Hospital	HVAC	11	1,355,024	397,239	3.41
	Lighting	8	917,158	428,761	2.14
	VSD	10	225,149	268,848	.84
	Boiler	1	2,000	177,056	.01
Library	HVAC	3	38,167	17,755	2.15
	Lighting	9	274,892	186,873	1.47
	VSD	10	909,358	545,723	1.67
	Boiler	2	2,180	33,086	.07
Office	HVAC	5	21,584	22,656	.95
	Lighting	19	169,402	81,262	2.09
	VSD	2	144,702	35,181	4.11
	Boiler	1	5,985	1,792	3.34